

REMARKS

The above amendments have been made pursuant to the filing of this new Divisional Application.

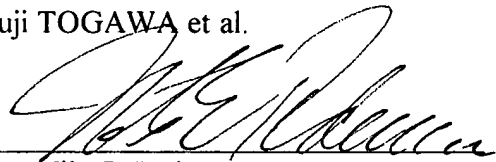
Attached hereto is a marked-up version of the changes made to the specification by the current Preliminary Amendment. The attached page is captioned "**Version With Markings to Show Changes Made**".

An early and favorable action on the merits is requested.

Respectfully submitted,

Tetsuji TOGAWA et al.

By



Nils E. Pedersen

Registration No. 33,145

Attorney for Applicants

NEP/krl
Washington, D.C. 20006-1021
Telephone (202) 721-8200
Facsimile (202) 721-8250
August 7, 2001

THE COMMISSIONER IS AUTHORIZED
TO CHARGE ANY DEFICIENCY IN THE
FEES FOR THIS PAPER TO DEPOSIT
ACCOUNT NO. 23-0975

polishing cloth 14 apply a predetermined pressure to the
polishing cloth 14. At the same time that or before the
dressing element 19 contacts the polishing cloth 14, a dressing
liquid such as water is supplied from the dressing liquid
5 supply nozzle 21 to the upper surface of the polishing cloth
14. The dressing liquid is supplied for the purposes of
discharging an abrasive liquid and ground-off particles of the
semiconductor wafer which remain on the polishing cloth 14 and
removing frictional heat that is generated by the engagement
10 between the dressing element 19 and the polishing cloth 14.
The dressing liquid supplied to the polishing cloth 14 is then
scattered outwardly off the turntable 9 into the frame 17 under
centrifugal forces caused by the rotation of the turntable 9,
and collected by the gutter 17a of the frame 17.

15 The cleaning units 7a, 7b and 8a, 8b may be of any
desired types. For example, the cleaning units 7a, 7b which
are positioned near the polishing units 1a, 1b may be of the
type which scrubs both sides, i.e., face and reverse sides, of
a semiconductor wafer with rollers having respective sponge
20 layers, and the cleaning units 8a, 8b which are positioned near
the wafer storage cassettes 2a, 2b may be of the type which
supplies a cleaning solution to a semiconductor wafer that is
being held at its edge and rotated in a horizontal plane. Each
of the cleaning units 8a, 8b also serves as a drying unit for
25 spin-drying a semiconductor wafer under centrifugal forces
until it is dried. The cleaning units 7a, 7b can perform a
primary cleaning of the semiconductor wafer, and the cleaning
units 8a, 8b can perform a secondary cleaning of the





semiconductor wafer which has been subjected to the primary cleaning.

Each of the transfer robots 4a, 4b has an articulated arm mounted on a carriage which is movable along the rail 3. The articulated arm is bendable in a horizontal plane. The articulated arm has, on each of upper and lower portions thereof, two grippers that can act as dry and wet fingers. The transfer robot 4a operates to cover a region ranging from the reversing units 5, 6 to the storage cassettes 2a, 2b, and the transfer robot 4b operates to cover a region ranging from the reversing units 5, 6 to the polishing units 1a, 1b.

The reversing units 5, 6 are required in the illustrated embodiment because of the storage cassettes 2a, 2b which store semiconductor wafers with their surfaces, which are to be polished or have been polished, facing upwardly. However, the reversing units 5, 6 may be dispensed with if semiconductor wafers are stored in the storage cassettes 2a, 2b with their surfaces, which are to be polished or have been polished, facing downwardly, and alternatively if the transfer robots 4a, 4b have a mechanism for reversing semiconductor wafers. In the illustrated embodiment, the reversing unit 5 serves to reverse a dry semiconductor wafer, and the reversing unit 6 serves to reverse a wet semiconductor wafer.

The polishing apparatus can be operated selectively in a series mode of polishing operation (hereinafter referred to as a serial processing) as shown in FIG. 4A and a parallel mode of polishing operation (hereinafter referred to as a parallel processing) as shown in FIG. 4B. The serial and

parallel processings will be described below.

FIGS. 4A and 4B show the states of the semiconductor wafers in respective positions;  shows the position in which the semiconductor wafers are in the state of their surfaces, which are to be polished or have been polished, facing upwardly;  shows the position in which the semiconductor wafers are in the state of their surfaces, which are to be polished or have been polished, facing downwardly;  shows the position in which the semiconductor wafers are in the state of their surfaces, which have been reversed and are to be polished, facing downwardly; and  shows the position in which the semiconductor wafers are in the state of their surfaces, which have been polished and reversed, facing upwardly.

(1) Serial processing (FIG. 4A):

In the serial processing, a semiconductor wafer is polished by means of a two-stage polishing, and three out of the four cleaning units 7a, 7b, 8b are operated to clean semiconductor wafers.

As shown by solid lines, a semiconductor wafer is transferred from the storage cassette 2a to the reversing unit 5. The semiconductor wafer is then transferred from the reversing unit 5 to the first polishing unit 1a after ^{being} reversed in the reversing unit 5. The semiconductor wafer is polished in the first polishing unit 1a and transferred therefrom to the cleaning unit 7a where it is cleaned. The cleaned semiconductor wafer is then transferred from the cleaning unit 7a to the second polishing unit 1b where it is polished. The

semiconductor wafer is then transferred from the second polishing unit 1b to the cleaning unit 7b where it is cleaned. The cleaned semiconductor wafer is then transferred from the cleaning unit 7b to the reversing unit 6. The semiconductor wafer is then transferred from the reversing unit 6 to the cleaning unit 8b after reversed in the reversing unit 6. The semiconductor wafer is then transferred from the cleaning unit 8b to the storage cassette 2a after ^{being} cleaned and dried in the cleaning unit 8b. The transfer robots 4a, 4b use the respective dry fingers when handling dry semiconductor wafers, and the respective wet fingers when handling wet semiconductor wafers. The pusher 12 of the polishing unit 1a, ^{which} receives the semiconductor wafer to be polished from the transfer robot 4b, is elevated and transfers the semiconductor wafer to the top ring 13 when the top ring 13 is positioned above the pusher 12. The semiconductor wafer which has been polished is rinsed by a rinsing liquid supplied from a rinsing liquid supply device which is provided at the pusher 12.

After the semiconductor wafer is ^{subjected} ~~applied~~ to a primary polishing in the polishing unit 1a, the semiconductor wafer is removed from the top ring 13 of the polishing unit 1a, and rinsed at the position of the pusher 12, and then cleaned in the cleaning unit 7a. Therefore, any abrasive liquid containing abrasive grains adhering to the polished surface, the reverse side of the polished surface, and side edge of the semiconductor wafer due to the primary polishing in the polishing unit 1a is completely removed. Then, the semiconductor wafer is applied to a secondary polishing in the

polishing unit 1b, and then cleaned by the primary cleaning process of the cleaning unit 7b and the secondary cleaning process of the cleaning unit 8b. Thereafter, the polished and cleaned semiconductor wafer is spin-dried and returned to the storage cassette 2a. In the serial processing, polishing conditions of the primary polishing and secondary polishing are different from each other.

(2) Parallel processing (FIG. 4B):

In the parallel processing, a semiconductor wafer is polished in a single polishing process. Two semiconductor wafers are simultaneously polished, and all ^{of} the four cleaning units 7a, 7b, 8a, 8b are operated to clean semiconductor wafers. One or both of the storage cassettes 2a, 2b may be used. In the illustrated embodiment, only the storage cassette 2a is used, and there are two routes in which semiconductor wafers are processed.

In one of the routes, as shown by solid lines, a semiconductor wafer is transferred from the storage cassette 2a to the reversing unit 5. The semiconductor wafer is then transferred from the reversing unit 5 to the polishing unit 1a after ^{being} reversed in the reversing unit 5. The semiconductor wafer is polished in the polishing unit 1a and transferred therefrom to the cleaning unit 7a, where it is cleaned. The cleaned semiconductor wafer is then transferred from the cleaning unit 7a to the reversing unit 6. The semiconductor wafer is then transferred from the reversing unit 6 to the cleaning unit 8a after ^{being} reversed in the reversing unit 6. Thereafter, the semiconductor wafer is transferred from the

cleaning unit 8a to the storage cassette 2a after ^{being} cleaned and dried in the cleaning unit 8a.

In the other of the routes, as shown by broken lines, another semiconductor wafer is transferred from the storage cassette 2a to the reversing unit 5. The semiconductor wafer is then transferred from the reversing unit 5 to the polishing unit 1b after ^{being} reversed in the reversing unit 5. The semiconductor wafer is polished in the polishing unit 1b and transferred therefrom to the cleaning unit 7b, where it is cleaned. The cleaned semiconductor wafer is then transferred from the cleaning unit 7b to the reversing unit 6. The semiconductor wafer is then transferred from the reversing unit 6 to the cleaning unit 8b after ^{being} reversed in the reversing unit 6. Thereafter, the semiconductor wafer is cleaned and dried in the cleaning unit 8b, and transferred to the storage cassette 2a. The transfer robots 4a, 4b use the respective dry fingers when handling dry semiconductor wafers, and the respective wet fingers when handling wet semiconductor wafers. The reversing units 5 handles a dry semiconductor wafer, and the reversing unit 6 handles a wet semiconductor wafer in the same way as ⁱⁿ the serial processing. In the above parallel processing, the primary cleaning process is ^{per}formed by the cleaning units 7a, 7b, and the secondary cleaning process is ^{per}formed by the cleaning units 8a, 8b. For cleaning a semiconductor wafer, either one of the cleaning units 7a, 7b and either one of the cleaning units 8a, 8b may be used. In the parallel processing, polishing conditions in the polishing units 1a, 1b may be the same, cleaning conditions in the cleaning units 7a, 7b may be

the same, and cleaning conditions in the cleaning units 8a, 8b may be the same.

FIG. 5 schematically shows in plan a polishing apparatus according to a second embodiment of the present invention. The polishing apparatus according to the second embodiment differs from the polishing apparatus according to the first embodiment in that the transfer robots 4a, 4b do not move on a rail, but are fixedly installed in position. The polishing apparatus shown in FIG. 5 is suitable for use in applications where semiconductor wafers are not required to be transferred in a long distance, and is simpler in structure than the polishing apparatus shown in FIG. 1. In this embodiment, the transfer line also extends between the polishing units and the storage cassettes.

The number of cleaning units, the number of transfer robots, and the layout of these cleaning units and transfer robots may be modified. For example, if the polishing apparatus is not operated in the parallel processing, then the polishing apparatus needs only three cleaning units. Whether the reversing units are to be used, the number, layout, and type of reversing units, the type of transfer robots, and whether the pushers are to be used may also be selected or changed as desired.

Example:

Semiconductor wafers were actually polished by the polishing apparatus according to the present invention. In the serial processing, the abrasive liquid applied by the polishing unit 1a was not carried over to the polishing unit 1b, thus

causing no contamination to the semiconductor wafers.

The wafer processing efficiencies, i.e., the throughputs (the number of processed wafers/hour) of a comparative polishing apparatus and the inventive polishing apparatus in both the serial and parallel processings are shown in Table given below:

Table

TT: turntable

	Throughputs (the number of processed wafers/hour)		
	1TT compar- ative	2TT serial	2TT paral- lel
processing time (seconds) per one wafer (1st TT / 2nd TT)	120/-	120/60	120/120
1TT(comparative)	19		
2TT(serial processing)		19	
2TT(parallel processing)			38

10

15

20

25

The comparative polishing apparatus employed one turntable, a required number of cleaning units, a required number of reversing units, and a required number of transfer robots. In serial and parallel processings, two turntables and two top rings are employed. As can be seen from Table above, the inventive polishing apparatus in the parallel processing has a throughput per turntable which is comparable to that of the comparative polishing apparatus. Therefore, the inventive polishing apparatus in the parallel processing has a greatly increased wafer processing capability per floor space.

As is apparent from the above description, according to the present invention, the polishing apparatus can improve the

quality and yield of workpieces by preventing the workpieces
from being contaminated with an abrasive liquid used in a
previous polishing process in a multi-stage polishing such as
a two-stage polishing, and can polish workpieces simultaneously
5 to increase throughput of the workpieces in a single-stage
polishing.

Further, according to the present invention, a serial
processing in which a two-stage polishing is performed and a
parallel processing in which a single-stage polishing is
10 performed can be freely selected.

In the embodiments, although the top ring handles
only one semiconductor wafer, the top ring may handle a
plurality of semiconductor wafers simultaneously. A plurality
of top rings may be provided in each polishing unit.

15 Although certain preferred embodiments of the present
invention have been shown and described in detail, it should be
understood that various changes and modifications may be made
therein without departing from the scope of the appended
claims.